(Fungi)

THE ASCOMYCETOUS FUNGI OF HUMAN EXCRETA

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The excreta of the human organism furnish a suitable habitat for the growth of various forms of cryptogamic vegetation. *Benuett* has called attention to the passage of intestinal discharges containing masses of confervoid growths and *Farre* has published a description of an alga of the genus Oscillaria from the same locality. *Beale*[1] and *Allchin*[2] have also alluded to similar facts. The presence of the spores of fungi has also been noticed by observers at various times. *Escherich*, according to *Von Jaksch* in his work on *Klinische Diagnostik*, has found in meconium species of *Torula* and numerous "*Hefepilze*." Often however, cocci in the stools are found in a toruloid or sarciniform arrangement. The yeast fungi in stools may be readily confused with morphological elements of quite similar appearance. The yeast fungi in stools may be distinguished by staining a mahogany brown upon the addition of a solution of Iodine in Potassium Iodide and water, while the false yeast cells stain blue. From the fact that the same fungus may assume various forms in its life history it is evident that the identification of fungus spores in the intestinal discharges is an extremely difficult matter and that it is necessary, oftentimes, to follow the round of the development and growth of the fungi from form to form, through the tangled mazes of form genera, before their proper systematic places can be satisfactorily determined, and the perfect state and final names be surely ascertained. Accordingly, most observers have been content with merely noting the occurrence of these minute vegetable organisms in the excretions of the human body. Some of the higher forms of fimicolous fungi are found growing upon excreta which have been voided for some time and it is possible that many of the minute forms of fungus spores found in recent excreta may be genetically connected with the later ascomycetous growths. We know that the development of many non-fimicolous fungi has been thus worked out. The recognition of the relation of fungi to plant diseases has lately stimulated research in this direction and at the institutions for the study of vegetable pathology ex-

periments are being continually prosecuted for the completion of the life history of various vegetable parasites. Furthermore the recognition by the medical profession of the relation of minute organisms to various pathological processes has directed attention to the presence of bacteria, fungi and such organisms as the *Amoeba coli* in human dejections, In May, 1890, the author, while examining microscopically some intestinal evacuations, noted the presence of a fungus of the genus *Fusarium* hitherto unreported from this country. It may be thus briefly described:

Sporodochia not satisfactorily made out, probably scattered and concolorous with the fæcal crust; basidia mostly simple, at times branched and sparingly septate; conidia fusoid, curved, triseptate, hyaline, 33-40 X 4-6 μ.

Hab. On human excrement, *Lyndonville*, *N. Y.*, May 1890, *C. E. Fairman.*

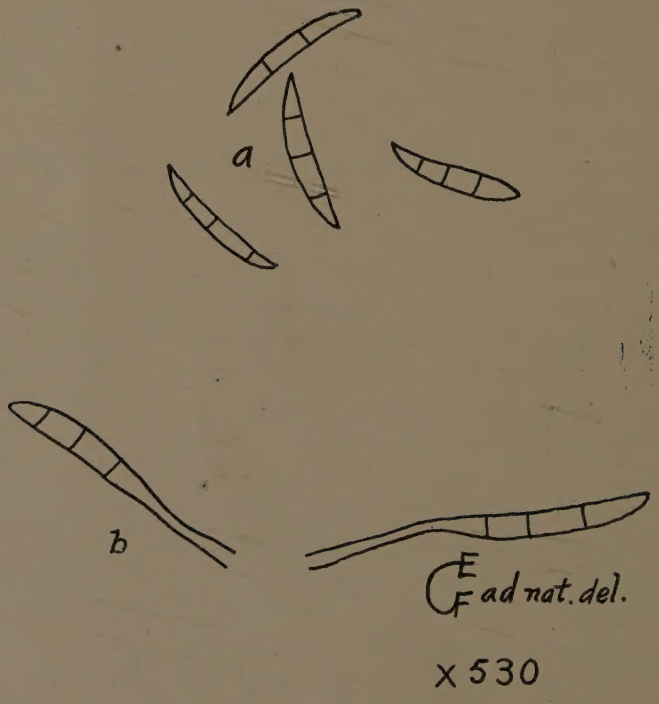

Fig. 1. Spores and hyphae of **FUSARIUM** *on human faeces.*

This *Fusarium*, doubtless, is only a state of some higher

or ascomycetous fungus which may be found on older fæcal discharges, under suitable conditions of temperature or moisture. The spores are provided with granular contents, are somewhat crescent-shaped, and divided by partitions or septa.

Spegazzini has described a *Fusarium* on human excrement from *Venice*, *Italy*, which he calls *Fusarium rostratum*, in which the conidia are falcate, fusoid, 2 to 3-septate, with the lower cell rostrate or elongate, 30-40 X 4.5-6 μ. This seems different from the form above mentioned in its rostrate conidia (*Speg. Michelia 1:*223, 1878. *Bizzoz. Fl. Ven. Crypt. 1:*538).

Not having seen the type of *Spegazzini's Fusarium* the author refrains from publishing the above mentioned form as new. Species of *Fusarium* have also been noted upon the excreta of various animals. *Fusarium* species are commonly met with upon rotting fruits and vegetables, a species called *Fusarium solani Mart*, occurring quite abundantly on decaying tomatoes and potatoes. See *Report of Chief of Section of Vegetable Pathology*, *U. S. Agric. Department*, *1889.*, *Reinke* and *Berthold* claim to have established by cultivation experiments that *Fusarium solani* is only the state of an ascomycetous fungus which they refer to the genus *Hypomyces*. *Wollenweber* and others have cultivated the *Fusarium* species and in many instances traced the perfect form.

Whether the *Fusaria* found upon human fæces came from the ingestion of infected food, such as tomatoes or potatoes, or were inoculated after voiding has not been investigated. Of many fungi it has been noted "that they have first a parasitic period, passed in the body of an animal host, and secondly, a saprophytic period passed on some suitable organic soil."

In Sept. 1917, the author found on human excrement on the ground among weeds a fungus apparently belonging to the genus *Cylindrocolla*. This fungus may be described as follows: Caespituli sessile, 500-2000 μ in diameter, discoid or pulvinate, gelatinous when fresh, fleshy, semi-transparent to hygrophanous, white or becoming pale brown with age, occurring singly or in groups of two or more; sporophores subfasciculate, hyaline, straight, simple or branching, granular, about 3-4 μ in thickness; spores acrogenous, single or at times catenulate, hyaline,

granular, 2 or more guttulate, oblong or subcylindric, subrotund or truncate at the ends, 6.66-13.33 X 3-4 μ.

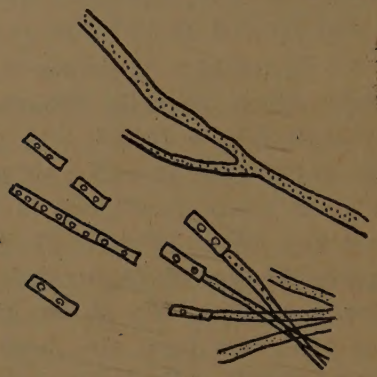

Fig. 2 Condidia and hyphae of CYLINDROCOLLA FAECALIS, sp. nov. Drawn with a GUNDLACH one-fourth obj. of seventy-five degrees.

The fungus almost disappears in drying and herbarium specimens fail to show its true character. The exact systematic place of this fungus is doubtful. It seems to come between *Cylindrocolla* and *Geotrichum*. In this connection we must consider that a species of *Geotrichum* has been announced as living on human excrement, viz: *Geotrichum lutescens*, (*Sacc.*) *Lindau*. This has yellow caespituli; conidiophores fasciculate, rarely branched, paler above, bearing at the ends catenulate, short cylindric, or subellipsoid conidia, which are hyaline and measure 10-12 X 6 or 8-10 X 4-5 μ. *Saccardo* considered it as a variety *lutescens* of *Geotrichum purpurascens* (Bon.) but *Lindau*, basing his opinion upon the different color of the caespituli and the form of the conidia, deems it a new species We find no mention of an early gelatinous condition in members of the genus *Geotrichum* and give to our fungus the provisional name of *Cylindrocolla faecalis* sp. nov.

Over a century ago *Ehrenberg* described in *Sylv. Mycol. Berol.*, (*1818*), page 10, a hyphomycete which he calls *Sporotrichum merdarium*. This has been reported from *Germany*, *France*, *England* and *Italy*. The caespituli of the fungus are yellow and subpulverulent, hyphae branched, roughened and trifid, with conidia which are yellow, globose, muriculate and

measure 9-10 μ in diameter. The species of *Fusarium* are mostly states of pyrenomycetous fungi, the *Cylindrocollas* are stages in the growth of discomycetous fungi, especially of the members of the genus *Calloria*, while the relationship of fungi belonging to the genera *Sporotrichum* and *Geotrichum* has not been at present clearly made out.

Wreden reports an ascomycetous fungus in the external auditory canal to which he gives the name *Otomyces purpureus* and *Buller*[4] tells us that the same thing has also been observed by *Bennett*. In *Wreden's* case the false membrane also contained "spots of *Aspergillus nigricans* and he was led to believe that *Otomyces purpureus* represented the ascomycete of the *Aspergillus nigricans*, that is the highest form of the specific aural fungus. *Burnett*, however, found no evidence of such relation ship and regards the *Otomyces purpureus* as a species sui generis." The growth of fungi in the auditory canal is called otomycosis and species of the genus Aspergillus (*Aspergillus nigricans*, *flavus* and *fumigatus*) are the most common fungi of the disease. Hence the affection is sometimes called mycosis aspergillina, aspergillus-mycose, and pinselschimmel-krankheit. *Aspergillus glaucus*, one of the most common microscopic fungi of the household, is considered to be the conidial stage of an ascomycetous fungus, *Eurotium herbariorum* (Wigg.) L., everywhere common on badly dried herbarium specimens, on wood, fruit and various putrid snbstances and belongs to the *Perisporiaceae* which includes our common mildews. In birds species *Aspergillus* cause a disease of the lungs which has been called *Pneumonomycosis aspergillina* and *Osler*, *Popoff* and others have recorded cases of pulmonary affection in man caused by species of *Aspergillus*. The symptoms of ear disease occasioned by the growth of *Aspergillus* are identical for the four or five different species recorded and consist mainly of pain, noises, deafness and discharges. Leber has observed a case of purulent Keratitis caused by *Aspergillus* infection. Some observers have contended that the numerous *Aspergilli* recorded as having been found growing in the human ear are not distinct from the common *Aspergillus glaucus*. It is probable that all the recorded species are conidial stages of ascomycetes. *DeBary* has

investigated the pleomorphism of *Aspergillus* and placed its sporocarp state in the genus *Eurotium.*

In the urine, also, fungus spores have been found which may be connected with ascomycetes.

Bennett and *Murray* [7] place under the head of doubtful ascomycetes the various species of *Saccarhomyces.* Without discussing here the appropriateness of this classification we have in this article considered them as degraded ascomycetes in order that their increasing importance in human pathology might be aonsidered along with the well defined ascomycetes. The *Saccharomycetes* are prevalent in fermentative processes of the

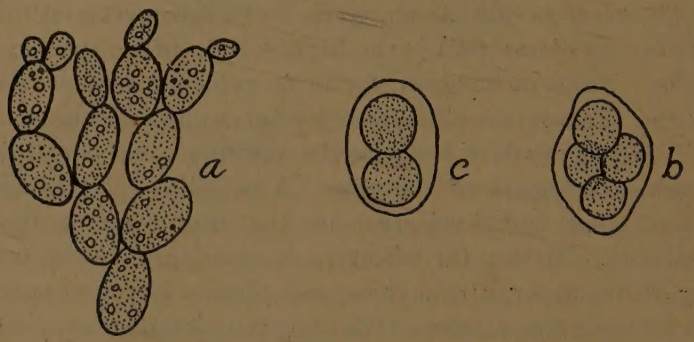

Fig. 3. SACCHAROMYCES sp. redrawn from BENNETT & MURRAY showing colony of sprout cells and cells with ascospores.

human body, are found in the excreta and occur in various pathological conditions. *Saccharomyces cerevisiae* (Meyen) is the ordinary yeast plant and many other members of this genus have the power of bringing about fermentation in diverse media. *Saccharomyces mycoderma* Rees generates alcoholic fermentation in various fruits and their expressed juices and according to *De Seynes* this species is often found in diabetic urine. The fungus which causes thrush, so long familiar to physicians under the name which Robin gave to it, viz: *Oidium albicans*, is classed by *Saccardo* in the Sylloge as a saccharomycetous plant, and called *Saccharomyces albicans* (Robin) Rees. Bolton [8] said that "no pathogenic saccharomycetes have been discovered." but this can no longer be affirmed. *Dr. J. B. DeToni* [6] in the enumeration of the *Saccharomycetaceae* in *Saccardo's Sylloge Fungorum* gives at least four species which

are said to be pathogenic, viz: *Saccharomyces albicans* (Robin) Rees, previously mentioned, *Saccharomyces psoriasis* (Riv.)Catt. said to be the cause of the skin disease psoriasis, *Saccharomyces capitillii* Oud. and Pekelh., which according to Pekelharing is probably the cause of pityriasis capitis and *Saccharomyces ovalis* Bizzozero which is often associated with the preceding species and of which it may be a smaller form.

The infectiousness of tumors has lately been in some case attributed to the saccharomycetes. The Italian pathologists *Sanfelice* and *Roncali* [9] have championed the theory that cancer and other malignant growths are caused by blastomycetes, a theory not generally accepted by pathologists. A disease of the skin, *blastomycetic dermatitis*, has been attributed to yeast fungi by *Gilchrist* and *Stokes*, by *Wells*, *Hessler* and *Hektoen* [10].

The fimicolous *Ascomycetes* are in many instances distinguished by certain peculiarities of structure. Thus, for instance, among the *Pyrenomycetes*, dung fungi of the genus *Sordaria* often have hyaline appendages at the extremeties of the sporidia and those belonging to *Hypocopra* and *Coprolepa* have sporidia surrounded by hyaline envelopes while Sporormia species have jointed sporidia which ultimately may separate at the joints. Among the *Discomycetes* the *Ascoboli* are peculiar dung fungi which have the fleshy disk rendered papillate from the protruding asci. Fuckel proposed a distinct group of Pyrenomycetes inhabiting dung, including many genera, to which he gave the name *Fimicoli*, and Dr. J. F. Seaver, in North American Flora 3;56 proposes the order *Fimitariales* for similar forms. Hickey has recently called attention to the practical value of a knowledge of the recognition of spores in the diagnosis of the more common helminthic infections of human beings. He says that " vegetable cells and cryptogam spores derived from the food may be mistaken for the eggs of parasites since they frequently appear in the faeces." For further details his paper may be consulted in U. S. Public Health Reports, vol. 35, number 11, page 1399, June 11, 1920. Hickey also calls attention to the presence in stools of *Diatomaceae* of both fresh and salt water, especially mentioning *Stauroneis* and *Coscinodiscus*.

In conclusion the ascomycetous fungi of human excreta are of interest from the probability that fungus spores in recent evacuations may be stages in the development of higher forms which are only seen on stools voided a long time, from the fact that some of them are recognized as the causes of disease and are met with in the diagnostic examination of faeces or other excretions.

We append a synopsis of such *Ascomycetae* as have been found in human tissues or excreta so far as they have come to the writer's knowledge, including some of the *Saccharomycetae*, the so called *Degraded Ascomycetae*.

NOTE:—Bruntz in Bull. Sci. Pharm. 26: 257-265, says that the spores of *Tilletia Tritici* have been found in feces from the probable eating of spoiled bread or flour and that these spores and also pollen grains should be distinguished from the eggs of helminths.

SYNOPSIS OF HUMAN ASCOMYCETAE.

PERISPORIACEAE

1. Perisporium funiculatum Pr. in Linn. n. 145.

Syn. *Fleishakia laevis* Auerswald. On human excrement and rotting stems, *Germany*. According to *Fuckel* the conidial stage of this fungus is *Torula nivea* and has globose or ovate, hyaline spores. 3-4 μ in diam.

2. Eurotium Herbariorum (Wigg.) Link

Aspergillus glaucus is the conidial stage,

3. Eurotium repens DeBary.

Hedw. 1871, p. 52. See *Siebenmann*, Die *Fadenpilze Aspergillus flavus niger* und *fumigatus*, *Eurotium repens* und ihre beziehungen zur *Otomycosis aspergillina*.

SPHAERIACEAE

4. Chaetomium humanum Karst. Symb. Myc. XXVII, p. 33.

This has not, to our knowledge, been found by any mycologist since *Karsten's* time. The color of the spores is unusual for this genus, and no one can say just what it really is. Said to have been found on human excreta in Mustiala, Finland.

5. Hypocopra humana Fckl. Symb. Myc. p. 241.

Syn. *Sordaria humana* Winter, Sord. p. 21. *Fimetaria humana* (Fuckel) *Griffiths & Seaver, North Amer. Flora 3:67*. Found on human excrement in *Germany, France, Italy, North and South America*.

6. Hypocopra stercoraria (Sow.) Sacc. Syll. 1: 244.

On human excrement in *Sweden* and *England*.

DISCOMYCETEAE

7. Humaria cremoricolor Berk. North Amer.Fungi, No. 714.

Cooke, Mycogr. f. 69. Found on human faeces in *South Carolina*.

8. Humaria merdaria Fr. Elench, II, page 11.

Cooke, Mycograph, fig. 69 On human excrement in *Russia*, *France and Sweden*.

9. Pyronemella araneosa Sacc. Mich. 1: 237.

On human faeces; *Italy*. *Saccardo* says that this species may be readily known by the spherical sporidia massed in the upper part of the asci.

10. Pyronema tapesioides Rehm Disc. p. 963.

On human excrement near *Berlin*, *Germany*, and on manured soil *Italy*.

11. Mollisia auriculae (Garov.) Sacc. Syll. 8:350.

Peziza auriculae Garov. in Arch. Trien-Lab. critt. *1*: 281. On cerumen from the human ear. Not having seen any confirmation of the occurrence of this fungus it must be considered doubtful

12. Ascobolus furfuraceus Pers. Obs. 1:33.

Universally distributed on dung of various animals, including man

13. Ascophanus subfuscus Boud. Ascob. p. 52, plate 10, f. 23.

Occurs on dung of dog, cats and man.

14. Ryparobius brunneus Boud. Ascob. p. 47, plate 9, fig. 23.

On human excrement, Montmorency, France.

GYMNOASCACEAE

15. Bargellinia monospora Borzi Malp, II, p. 476.

Found in discharges in catarrh of the external auditory meatus, *Messina*, *Italy*. This is unconfirmed and doubtful.

UNCLASSIFIED

Otomyces purpureus Wreden.

The author has seen no description of this fungus. *Prof. F. C. Stewart* sends the following information: "I have been unable to find any reference to the genus *Otomyces* in Saccardo's Sylloge. In fact, I find nothing about it anywhere except in Rabenhorst's Kryptogamen-Flora, vol, 8, p. 136. Here is given a description of *Aspergillus Hageni* (Hallier) with *Otomyces Hageni* Hallier in Zeitschr. fur Parasitenkunde *1*, p. 195 (1869) given as a synonym." *Otomyces purpureus* Wreden and *Otomyces Hageni* Hallier may be nothing but species of *Aspergillus*, or *Eurotium*.

DEGRADED OR DOUBTFUL ASCOMYCETES

SACCHAROMYCETACEAE

16. Saccharomyces mycoderma Rees. Bot. Unters. p. 83.

According to *De Seynes* this fungus is occasionally found in diabetic urine.

17. Saccharomyces albicans (Robin) Reese.

On the oral mucous membrane, and discharges.

18. Saccharomyces coprogenus Sacc. & Speg.

On fermenting human faeces, in *Italy*. This is said to form a coating like a *Corticium*.

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12 OCT. 1920

EXPLANATION OF THE PLATE

HYPOCOPRA HUMANA, from a specimen in the author's herbarium collected by J. B. Ellis at Newfield, New Jersey. (a.) sporidia involved in mucus; (b.) an ascus with eight sporidia.

ASCOBOLUS FURFURACEUS, from a specimen collected by the author at Lyndonville, N. Y. (c.) ascus with sporidia; (d.) a paraphysis. From a camera lucida sketch by the author.

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